21-year-old female with papillary thyroid carcinoma

Celeste Thomas MD
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History of Present Illness

- 21-year-old woman
- Saw her PCP to request a referral to dermatology
- Found to have a fullness in her neck on the left side
  → ultrasound → FNA → papillary thyroid cancer
- CT imaging concerning for left lymph node involvement
- No dysphagia, cough, shortness of breath, dysphonia
History of Present Illness

- No family history of thyroid cancer
- Employed as a radiation technologist in a veterinarian’s office
  - Past three years (since age 19)
  - Each animal gets approximately three images while she is holding them
  - She hold four animals a day, three to four days a week
  - Wears a lead garment to cover her trunk but no thyroid collar
History

- **Past Medical History**
  - Gluten Sensitivity
  - Anemia

- **Past Surgical History**
  - Tonsillectomy, age 13

- **Allergies:** NKDA
- **Medications:** None

- **Family History**
  - Mother with history of nontoxic goiter, being evaluated for hyperparathyroidism
  - No thyroid cancer

- **Social History**
  - Employment
  - Tobacco, 5 cigarettes in lifetime
  - Rare alcohol use, No illicit drugs
Physical Exam

- Vital signs: BP 102/61, Pulse 58, Temp 96.3, RR 18 Ht 5’6”, Wt 155 lb
- Gen: well-nourished, no distress
- HEENT: EOMI, no Chvostek sign
- Neck: incision c/d/l, JP drain in left neck
- CV: regular rate, no extra heart sounds
- Pulm: good respiratory effort, lungs CTAB
- Abd: bowel sounds present, soft, nontender
- Neuro: sensation intact to light touch
Ultrasound
Final Pathologic Diagnosis

- Complete thyroidectomy:
  - Papillary thyroid carcinoma, multifocal (largest nodule 2.5 cm)
  - Chronic lymphocytic thyroiditis
  - Parathyroid tissue without diagnostic abnormality
- Left neck contents, excision
  - Five level II lymph nodes, no tumor
  - Metastatic papillary thyroid carcinoma in 5 of 12 level III lymph nodes
  - Metastatic papillary thyroid carcinoma in 2 of 4 level IV lymph nodes
Radiation Units

- **Activity**: The number of times each second a radioactive material decays and releases radiation
  - Disintegration/sec = 1 **Becquerel** (Bq)
  - 37 billion Bq = 1 curie

- **Dose (absorbed)**: The amount of radiation energy absorbed into a given mass of tissue
  - 1 joule/kg = 1 **Gray**
  - 1 Gray = 100 rad (1 cGy = 1 rad)

- **Dose (equivalent)**: energy per unit mass times adjustments for the type of radiation involved (quality factor) and the biological response in the tissue (a weighting factor)
  - Gray x quality factors = **Sievert** (Sv)
  - 1 Sievert = 100 rem
U.S. annual per-capita effective radiation dose from various sources for 1980 using United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) value of 2.4 mSv for natural background.

Mettler FA et al. Radiology 2009;253:520-531
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Classic Paradigm of Radiation Injury (High Dose)

 Ionizing Radiation

 Chemical "Repair" (ions recombine)

 Damaged non-DNA molecules replaced

 Enzymatic DNA Repair

 DNA Damage

 Unrepaired, Misrepaired DNA

 Cell Death - many

 Developmental Effects (fetal)

 Late Effects of Radiation Damage

 Mutant Cells

 Early Effects Radiation Sickness

 Cancer

 Heritable Genetic Effects

 Germ line

 Somatic (Malignant Transformation)

 < 1 Second  Min - Hours  Days - Decades
Low Doses show other pathways....

Ionizations
Chemical changes (Free radical formation, etc)

DNA Damage

Enzymatic DNA Repair
Enhanced DNA Repair

Cell replication
Tissue remains healthy

Cell Deaths - few

Mutant Cell

Apoptosis

Molecular sensors trigger altered activity
Altered antioxidant status

Developmental Effects (lethal)
Late Effects of Radiation Damage
Heritable Genetic Effects

Early Effects Radiation Stiffness

Cancer

Microenvironment (Protects multi-cellular organism at low doses)

< 1 Second  Min - Hours  Days - Decades
United States Radiologic Technologists Cohort

- All registered radiologic technologists certified for a minimum of 2 years (N = 146,022) as of 1982
  - Baseline questionnaire to 133,519 in 1983-1984 (90,305 responded)
  - Second questionnaire mailed to 125,707 in 1994 (91,173 responded)
  - Both questionnaires completed and returned by 70,859 technologists
Radiation Technologists cohort

- Follow-up of the cohort
  - Date of first questionnaire completion until diagnosis of thyroid cancer, death, or completion of second questionnaire
  - Participants reporting a diagnosis of thyroid cancer were contacted to obtain consent and acquire medical records
  - Era employed was considered given improvement in radiation safety over time
## Characteristics of Participants with Thyroid Cancer diagnosed during the first follow-up

<table>
<thead>
<tr>
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<th>Thyroid Cancer after baseline</th>
<th>Thyroid Cancer Free</th>
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<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
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<tr>
<td><strong>Gender</strong></td>
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<td>86</td>
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<tr>
<td>Male</td>
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<tr>
<td><strong>Age at Baseline</strong></td>
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<tr>
<td>&lt;30</td>
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<tr>
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<td><strong>Age First Worked</strong></td>
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<tr>
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<td><strong>Ever smoked 100 cigarettes</strong></td>
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<tr>
<td><strong>Prior Thyroid Condition</strong></td>
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<td>22.3</td>
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Results

- Early employment before 1950 was found to be associated with increased incident thyroid cancer before completion of the baseline survey.
- The only determinant of occupational exposure that was related to prospective thyroid incidence was:
  - Holding the patients for procedures at least 50 times, HR = 1.47 95% CI 1.01 – 2.15
References

- U.S. Department of Energy, Office of Science, Low Dose Radiation Research Program